What is claimed is:

1. An optical coupling arrangement for providing a signal path into and out of a silicon optical waveguide formed in a surface layer of a silicon-on-insulator (SOI) wafer comprising a silicon optical waveguide layer disposed over an insulator layer formed on a silicon substrate, the optical coupling arrangement comprising

a silicon-based prism coupler disposed to intercept an incoming optical beam from a light source, said silicon-based prism coupler being permanently attached to said SOI wafer in a manner such that a first surface of said prism coupler is disposed substantially parallel to, and mated with, a flat surface of said SOI wafer, the refractive index of said silicon-based prism coupler equal to or greater than the refractive index of said silicon optical waveguide;

free-space micro-optic input elements interposed between the light source and the silicon-based prism coupler, to collimate, shape and steer the optical beam to a specific entry point and angle of incidence upon the silicon-based prism coupler;

an evanescent coupling region disposed between said silicon-based prism coupler and said silicon optical waveguide; and

free-space micro-optic optic elements placed in the path of the beam that emerges from the output surface of the silicon-based prism coupler, to shape, collimate or focus the optical beam, and to steer the optical beam toward a receiving element.

2. The optical coupler arrangement of claim 1, wherein the arrangement further comprises a light source coupled to the free-space micro-optic input elements

3. The optical coupling arrangement of claim 2, wherein the wavelength of the light source falls in the range of 1.1 – 1.65 μm.

4. The optical coupling arrangement of claim 2, wherein the output beam of the light source is substantially single-mode.

5. The optical coupling arrangement of claim 2, wherein substantially all the power of the light source falls within ± 5 nm of the center wavelength.

6. The optical coupling arrangement of claim 2, wherein the light source is an edge-emitting laser diode.

7. The optical coupling arrangement of claim 5, wherein the micro-optic free-space input elements subsequent to the edge-emitting laser diode include a first micro-optic element to reduce the divergence angle of the output beam perpendicular to the junction to the magnitude of the divergence angle of the output beam parallel to the junction, correct astigmatism, and produce a circular beam, followed by a second micro-optic element to collimate the beam.

8. The optical coupling arrangement of claim 6, wherein the micro-optic free-space input elements subsequent to the edge-emitting laser diode include a gradient-index micro-cylindrical lens to collimate the output beam perpendicular to the junction, followed by a second micro-cylindrical lens to collimate the output beam parallel to the diode junction.

9. The optical coupling arrangement of claim 6, wherein the micro-optic free-space input elements subsequent to the edge-emitting laser diode includes a first ball lens to collimate the beam, followed by a second ball lens to focus the beam to a receiving optical fiber assembly interposed between the diode and the silicon-based prism coupler.

10. The optical coupling arrangement of claim 6, wherein the micro-optic free-space input elements subsequent to the edge-emitting laser diode includes a first aspheric lens to collimate the beam, followed by a second aspheric lens to focus the beam to a receiving optical fiber assembly interposed between the diode and the silicon-based prism coupler.

11. The optical coupling arrangement of claim 6, wherein the micro-optic free-space input elements subsequent to the edge-emitting laser diode include a micro-optic waveplate to rotate the direction of polarization.

12. The optical coupling arrangement of claim 2, wherein the light source is a vertical-cavity surface-emitting laser diode.

13. The optical coupling arrangement of claim 12, wherein the micro-optic free-space input elements subsequent to the vertical-cavity surface-emitting laser diode include a micro-optic collimating lens.

14. The optical coupling arrangement of claim 13, wherein the micro-optic collimating lens is a silicon micro-lens.

15. The optical coupling arrangement of claim 12, wherein the micro-optic free-space input elements subsequent to the vertical-cavity surface-emitting laser diode include a micro-optic waveplate to rotate the direction of polarization.

16. The optical coupling arrangement of claim 12, wherein the micro-optic free-space input elements subsequent to the vertical-cavity surface-emitting laser diode include an optical element that converts an incident beam with unknown polarization state into two separate output beams of the same known polarization state, with the second beam displaced from, but substantially parallel to, the first beam.

17. The optical coupling arrangement of claim 2, wherein the light source is an optical fiber.

18. The optical coupling arrangement of claim 17, wherein the optical fiber is single-mode and supports any polarization state.

19. The optical coupling arrangement of claim 17, wherein the optical fiber is . single-mode polarization-maintaining fiber.

20. The optical coupling arrangement of claim 17, wherein the micro-optic free-space input elements subsequent to the optical fiber include a micro-optic collimating lens.

21. The optical coupling arrangement of claim 20, wherein the micro-optic collimating lens is fused to the optical fiber to form a lensed fiber.

22. The optical coupling arrangement of claim 21, wherein the collimated beam diameter exiting the lensed fiber ranges in size from 10 – 110 μm.

23. The optical coupling arrangement of claim 17, wherein the micro-optic free-space input elements subsequent to the optical fiber include an optical element that converts an incident beam with unknown polarization state into two separate output beams of the same known polarization state, with the second beam displaced from but substantially parallel to the first beam.

24. The optical coupling arrangement of claim 1, wherein the micro-optic free-space input elements include a refractive wedge of a material of high refractive index, to effect an angular deflection of the incident beam.

25. The optical coupling arrangement of claim 1, wherein the micro-optic free-space input elements include a reflective element that can be translated and rotated through an electronic actuation mechanism, to effect a translation and an angular deflection of the incident beam.

26. The optical coupling arrangement of claim 1, wherein the micro-optic free-space input elements include a diffractive optical element to effect an angular deflection of the incident beam.

27. The optical coupling arrangement of claim 1, wherein the evanescent coupling region is substantially constant in thickness.

28. The optical coupling arrangement of claim 1, wherein the evanescent coupling region is tapered in thickness.

29. The optical coupling arrangement of claim 1, wherein the arrangement further comprises an optical receiving element disposed to receive the output optical beam from the free-space micro-optic output elements.

30. The optical coupling arrangement of claim 29 wherein the receiving element is an optical fiber.

31. The optical coupling arrangement of claim 30, wherein the receiving optical fiber is a lensed fiber.

32. The optical coupling arrangement of claim 1, wherein input and output micro-optic elements, and the input and output surfaces of the silicon-based prism coupler, are covered with antireflective coatings.

33. An optical coupling arrangement for providing a signal path into and out of a silicon optical waveguide formed in a surface layer of a silicon-on-insulator (SOI) wafer comprising a silicon optical waveguide layer disposed over an insulator layer formed on a silicon substrate, the optical coupling arrangement comprising

a silicon-based prism coupler permanently attached to said SOI wafer in a manner such that a first surface of said prism coupler is disposed substantially parallel to, and mated to, a flat surface of said SOI wafer, the refractive index of said silicon-based prism coupler equal to or greater than the refractive index of said silicon optical waveguide;

optical elements formed as integral parts of said silicon-based prism coupler, to collimate, shape and steer the input optical beam to a specific entry point and angle of incidence upon the coupling surface of the silicon-based prism coupler;

an evanescent coupling region disposed between said silicon-based prism coupler and said silicon optical waveguide; and

free-space micro-optic output elements placed in the path of the beam that emerges from the output surface of the silicon-based prism coupler, to shape, collimate or focus the optical beam, and to steer the optical beam toward a receiving element.

34. The optical coupling arrangement of claim 33, wherein micro-lenses are formed in surfaces of the silicon-based prism wafer other than the mating surface to the SOI wafer, to effect collimation of the incident beam.

35. The optical coupling arrangement of claim 33, wherein diffractive optical elements are formed on surfaces of the silicon-based prism wafer other than the mating surface to the SOI wafer, to effect shaping, dispersion or an angular deflection of the incident beam.

36. The optical coupling arrangement of claim 33, wherein angled surfaces are anisotropically etched in the silicon-based prism coupler, to effect an angular deflection of the incident beam through total internal reflection.

37. The optical coupling arrangement of claim 33, wherein a subset of surfaces formed in the silicon-based prism coupler are coated with thin metal layers to serve as reflective elements and effect an angular deflection of the incident beam.

38. The optical coupling arrangement of claim 33, wherein the evanescent coupling region is tapered in locations where the optical beam enters the waveguide from the silicon-based prism coupler at the input prism coupling surface, and exits the waveguide to the silicon-based prism coupler at the output prism coupling surface, such

that a substantially Gaussian mode profile characterizes the optical beam at all points in the optical coupling arrangement external to the waveguide of the SOI wafer.

39. The optical coupling arrangement of claim 38, wherein the substantially Gaussian mode profile of the output beam resulting from use of the tapered region of the evanescent coupling layer enables high-efficiency coupling to a receiving fiber.

40. The optical coupling arrangement of claim 33, wherein the thickness of the waveguide of the SOI wafer is selected such that light launched from the source parallel to the wafer surface, and incident upon the input prism facet, is refracted by the silicon-based prism coupler at an angle that is associated with high coupling efficiency for a specific wavelength.

41. The optical coupling arrangement of claim 33, wherein the thickness of the waveguide of the SOI wafer is selected such that light launched from the source perpendicular to the wafer surface, and incident upon the input prism facet, is refracted by the silicon-based prism coupler at an angle that is associated with high coupling efficiency for a specific wavelength.

42. The optical coupling arrangement of claim 33, wherein the arrangement further comprises a light source.

43. The optical coupling arrangement of claim 42, wherein the light source is a vertical-cavity surface-emitting laser diode of an appropriate wavelength.

44. The optical coupling arrangement of claim 33, wherein the thickness of the waveguide of the SOI wafer is selected such that light launched from the source, and incident upon the input prism facet, is refracted by the silicon-based prism coupler such that the projection of the optical beam upon the prism coupling surface remains substantially constant over a wide range of wavelengths.

45. The optical coupling arrangement of claim 1, wherein the thickness of the waveguide of the SOI wafer is selected such that the thickness of the evanescent coupling region that optimizes coupling efficiency for a given wavelength and input beam size is substantially equal to a quarter-wave thickness of the material that comprises the evanescent coupling region for the same wavelength.

46. The optical coupling arrangement of claim 45, wherein the evanescent coupling layer and the anti-reflective coating for the silicon-based prism wafer may be formed simultaneously, using one process step.